Sediment Mixing in Coastal Regions: The Impact of Animal Digestion on Radionuclide Tracers

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LONG-TERM GOALS

We wish to further our understanding of the solubilization of metallic elements during passage of marine sediments through the digestive systems of deposit feeders. Of particular interest are the implications of this solubilization for the dissolution of metallic contaminants in sediments and the metallic radionuclides used in measuring sediment bioturbation.

OBJECTIVES

We will test for the chemical mechanisms by which various metals are solubilized by the ligands present in digestive fluids. We hope to isolate specific ligand groups involved in binding the metals. We will also see if the metallic radionuclides used in bioturbation, such as Th-234 and Pb-210, are significantly solubilized by digestive fluids. If so, we will assess what matrices holding these radionuclides are particularly vulnerable to the dissolution process. Implications for bioturbation modelling will be assessed based on these results.

APPROACH

Our general approaches are to (1) to conduct incubation experiments with gut fluids of deposit feeders to assess the amount of metallic radionuclides solubilized from the sediments, (2) to determine both intrinsic (organismal) and extrinsic (sedimentary) factors contributing to the solubilization, and (3) to corroborate the incubation experiments with *in vivo* solubilization and bioaccumulation measurements.

WORK COMPLETED

A series of experiments was conducted to narrow in on potential solubilizing ligands in gut fluids for Pb. A postdoctoral research associate, David Shull, began working in my laboratory in January. After renovating a portion of our laboratory, we installed an alpha and an ultra-low level gamma detector system. We then began a series of incubation experiments using *Arenicola marina* gut fluid to determine the extent of dissolution of ^{210}Pb, ^{234}Th and ^{137}Cs from sediments. Experiments with ^{7}Be will begin shortly. We have conducted gut-fluid incubation experiments with natural sediments. We have also conducted experiments using algal cells artificially labeled with radionuclides to investigate solubilization mechanisms.

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RESULTS

Experiments with natural sediments indicated little net radionuclide dissolution in gut fluid. However, experiments with artificially labeled algae indicated significant dissolution of ^{210}Pb but comparatively little dissolution of ^{234}Th. Although gut fluids can dissolve significant fractions of ^{210}Pb adsorbed to algae, incubation experiments conducted with mixtures of labeled algae and natural sediment indicate that ^{210}Pb-binding sites on mineral phases may compete with gut fluids for the dissolved ^{210}Pb (Fig. 1).

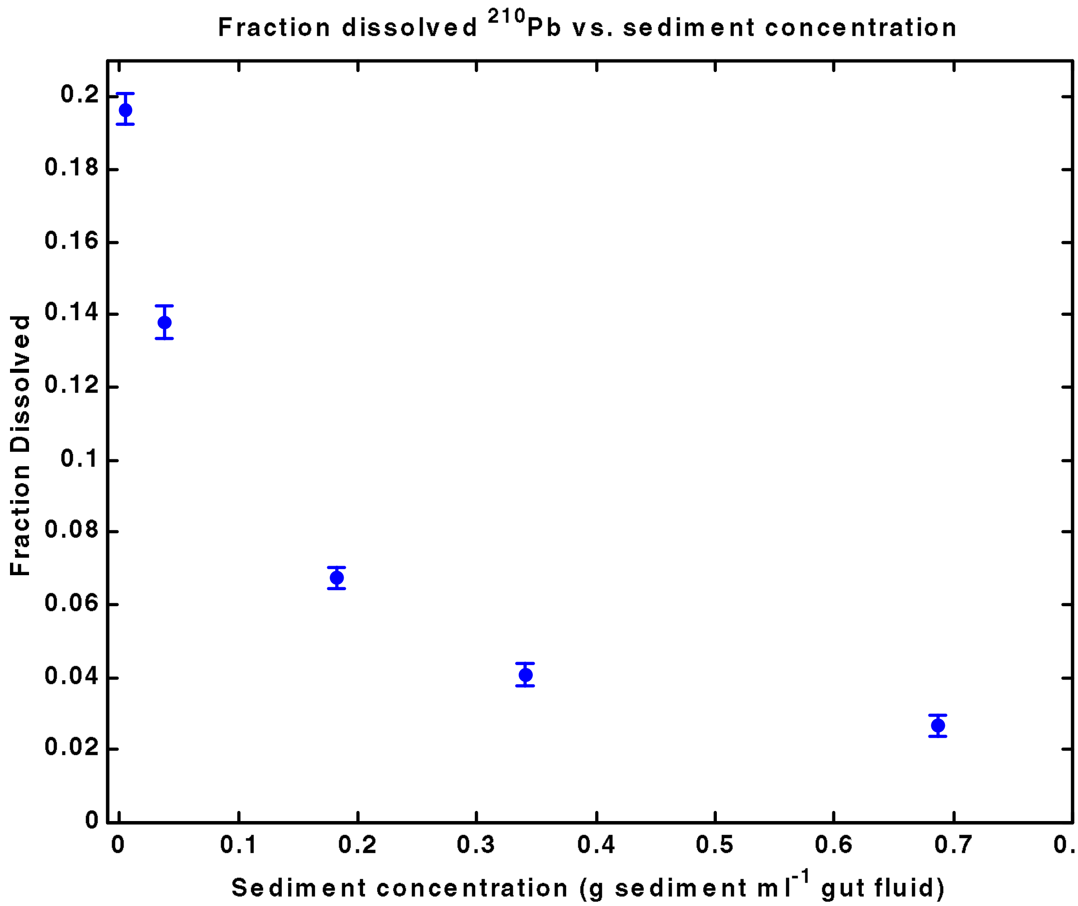

Figure 1. Fractional dissolution into Arenicola marina digestive fluid of ^{210}Pb from ^{210}Pb-labeled algae (y-axis) mixed with varying amounts of natural sediment (x-axis). The algal-sediment ratio used in this experiment bracket the range typical of nearshore sediments. Digestive fluids dissolved about 20% of the ^{210}Pb adsorbed to algae. The presence of sediment in the gut decreases the net dissolution of ^{210}Pb, presumably due to resorption of the dissolved ^{210}Pb onto mineral phases.

IMPACT/APPLICATIONS

These results indicate that deposit feeders can dissolve algal-bound ^{210}Pb. The matrix that binds ^{210}Pb thus may shift from algae, or other labile food substrates, to mineral surfaces due to deposit-feeder gut passage. These findings are consistent with observations of ^{210}Pb mobility in marine sediments. The potential effects of ^{210}Pb dissolution on the quantification of sediment mixing rates will be examined through kinetics experiments and bioturbation modeling.

TRANSITIONS

None

RELATED PROJECTS

Our ligand identification results further build our basis for contributions on metal bioavailability in polluted systems, such as a pending project being considered by the Army Corps of Engineers. We are also building a collaborative bioturbation-modeling program with Dr. B. P. Boudreau. His model design should benefit from our findings, and his models will allow tests of their implications after scaling to community and system levels.